Computational Imaging 2023:
Expert Forum with International Specialists in Wetzlar

10. & 11. May, 2023

Dr. Benjamin Dück
Leica Camera AG, Wetzlar

Developing Professional Cameras: Past, Present and Future

The Art and Science of developing cameras is changing dramatically. Developing and optimizing single components was sufficient in analog times. In digital times, endless new opportunities can be found to add customer value to our products by optimizing camera systems in its entirety. This talk will focus on benefits that have been harnessed already to showcase the power of the systems approach with an outlook to the future.

Prof. Sophie Triantaphillidou
Computational Vision and Imaging Technology, University of Westminster, London, UK
(triants@westminster.ac.uk)

Spatial Frequency Response estimation from natural scene captures

Camera Spatial Frequency Response (SFR) characterization is traditionally carried out using dedicated test-charts in controlled laboratory conditions. Yet, the test-chart, lab-based standardized traditional SFR measurement of modern camera systems incorporating computational photographic technologies is problematic. The talk will focus on research for estimating camera SFRs directly from natural scene captures and discuss the benefits of such an approach; including the potential for live camera SFR measurement, accounting for non-linear adaptive image processing, and providing innovative tools to the industry and the general public for digital camera evaluation.

Dr. Sebastian Bosse
Fraunhofer HHI, Berlin

Towards neural representations of perceived visual quality.

Accurate computational estimation of visual quality as it is perceived by humans is crucial for any visual communication or computing system that has humans as the ultimate receivers. But most importantly besides the practical importance, there is a certain fascination to it: While it is so easy, almost effortless, to assess the visual quality of an image or a video, it is astonishingly difficult to predict it computationally. Consequently, the problem of quality estimation touches on a wide range of disciplines like engineering, psychology, neuroscience, statistics, computer vision, and, since a couple of years now, on machine learning. In this talk, Sebastian gives an overview of recent advances in neural network-based-approaches to perceptual quality prediction. He examines and compares different concepts of quality prediction with a special focus on the feature extraction and representation. Through this, Sebastian revises the underlying principles and assumptions, the algorithmic details, and some quantitative results. Based on a survey of the limitations of the state of the art, Sebastian discusses challenges, novel approaches and promising future research directions that might pave the way towards a general representation of visual quality.

Computational Imaging 2023:
Expert Forum with International Specialists in Wetzlar

10. & 11. May, 2023

Prof. Ivo Ihrke
Universität Siegen

Light Field Imaging and Rich-Data AI

Light field imaging is by now a classical computational imaging technique. The trade-off between spatial and directional resolution is well known. The technique is particularly powerful when investigating smaller objects since in this case triangulation angles are large. However, we also meet higher variability in terms of other optical properties such as material reflectivity, illumination dependence and resolution restrictions due to wave optical effects. I will discuss our main insights over the development of the KLens light field lens, a detachable, fully optical, light field system, as well as applications involving processing and post-processing by AI algorithms. I will argue that light field and filtered light field data presents a rich data source for training high performance AI systems.

Prof. Radu Timofte
Universität Würzburg

Advances in Learning ISP and Mobile AI

in progress

Dr. Dirk Voelkel / Sebastian Tille
Leica Microsystems Wetzlar

From Eye to Insight: Innovations Impacting Human Health

Microscopy had entered the digital age already decades ago when A&D conversion of analog video signals and later digital cameras were introduced that paved the way towards processing of the digitized data for qualitative and quantitative analysis – providing insights in a separate step – post-acquisition. Today, we look at a more recent, second major evolution of imaging applications thanks to latest technology developments in the field of electronics, computing, (AI) algorithms and analysis. These enabled real-time processing of increasingly large image data sets, and thus are empowering scientists, surgeons and industrial microscopy users to make instant decisions at the point of impact. In this presentation, we want to show some examples of these amazing new possibilities that Leica Microsystem is providing to its user communities and highlight some of the enabling technology developments.

Dr. Robert Prevedel
Group Leader, Cell Biology and Biophysics Unit, EMBL Heidelberg

How computational approaches can revolutionize light microscopy in the life sciences

Light microscopy is a powerful and non-invasive tool to observe biological morphology and function at high spatial resolution over prolonged time periods, yet capturing highly dynamic processes over extended 3D volumes is a recurring challenge. In my talk I will present recent work from my laboratory in which we used computational approaches and imaging techniques such as light-field microscopy to achieve near instantaneous three-dimensional imaging. Time permitting, I will also share my perspective on future work and challenges in this highly innovative and interdisciplinary area of research.

Prof. Jan Huisken
Universität Göttingen

Compact, modular light sheet microscopes for remote smart microscopy

Light microscopy has given scientists unique insights into the details and dynamics of life from the sub-cellular to the organismal level. In recent years, the microscope has turned into a machine that does not only produce single images but rather multi-dimensional datasets in high spatial and temporal resolution. In particular, light sheet microscopy has revolutionized how we capture the complex dynamics of developing organisms with the instrument's high speed and low phototoxicity. However, the data's complexity is beyond what we can visually comprehend by simply looking through a microscope. A thorough under¬standing of multicellular life requires quantitative measurements and statistics on a larger ensemble to judge the variability and significance of the findings. Therefore, intelligent feedback between control, acquisition and processing is essential for future microscopy. A smart measurement will prevent us from drowning in data and allow us to capture the relevant aspects of a biological process.

Instead of pushing the performance of a single instrument in the lab, we decided to develop a microscope framework (Flamingo) that allows us to build many custom microscopes from reusable modules. It now provides a portable, reliable, and sustainable platform for both internal projects and external collaborations. The underlying electronics and software also allow for remote control, facilitating real-time image analysis and feedback to the instrument. The ability to control a high-end light sheet microscope with a simple set of instructions, paired with its fast and gentle acquisition, opens up possibilities for sample recognition, real-time image acquisition optimization, and unsupervised data recording. With several microscopes running continuously and generating data with high information content and only little overhead, we will address fundamental questions in developmental biology that could not be tackled with conventional imaging techniques.

Computational Imaging 2023:
Expert Forum with International Specialists in Wetzlar

10. & 11. May, 2023

Dr. Denis Schapiro
Univ. Heidelberg

“Google Maps” for tissue biology – Mapping tissues with spatial omics technologies.

With improvements in the speed and amount of spatial omics data that can be collected from tissues, data processing and analysis have become major challenges. Therefore, we developed the open-source histology topography cytometry analysis toolbox (histoCAT), which became the first software specifically tailored to analyze highly multiplexed images. HistoCAT includes advanced machine learning approaches and basic statistical methods integrated in an interactive desktop application. Recently, we have developed a scalable and modular computational pipeline (MCMICRO) enabling the analysis of a variety of spatial omics technologies. We demonstrated the use of MCMICRO on dozens of tissue and tumor images acquired using multiple imaging platforms, thereby providing a solid foundation for the continued development of tissue imaging software. In the second part of my talk, I will cover the Minimum Information about Highly Multiplexed Tissue Imaging (MITI) standard as well as our spatial power analysis framework to improve experimental design strategies.

Dr. Yvan Peng
University of Hongkong

Neural Holograpyh Family (tbd)

Light field and holographic near-eye displays promise unprecedented capabilities for VR/AR/MR systems. However, the image quality achieved by traditional displays is limited, especially in the sense of delivering the natural focus cues. This talk covers a family of Neural Holography advances that leverage the advantages of camera-in-the-loop optimization and neural-network model representation to deliver dynamic, full-color, high-quality holographic images. Driven by trending machine intelligence, these hardware-software joint design techniques can unlock the full potential of VR/AR/MR systems.

Prof. Carl Kesselmann
University of Southern California

Avoiding Garbage In/Garbage Out: A Data Centric Perspective to Making Computational Imaging Experiments Sharable and Reproducible.

in progress

Computational Imaging 2023:
Expert Forum with International Specialists in Wetzlar

10. & 11. May, 2023

Prof. Christmann
Pascal Kutschbach, Mark Banyamin, Hochschule Rhein Main

AI-based HDR reconstruction & expansion for video applications

In recent years, a dynamic and real-time capable tone mapping algorithm for video applications has been developed at RheinMain University of Applied Sciences. This method analyzes the global and local brightness distributions of HDR/WCG content and transfers it into SDR/SCG color- and brightness ranges. Furthermore, the method has been extended with a dedicated color volume mapping system. The CVM considers the color perception capabilities of the human visual system and avoids clipping during the transformation of image pixels. To make these methods more robust, and in particular to enable an appropriate upconversion from SDR/SCG to HDR/WCG, it is reasonable to make use of artificial intelligence. The application of this technology in the field of motion image processing on the condition of real-time applicability is a challenge that RheinMain University currently faces.

Dr. Feiyan Hu
Dublin City University

Fast and efficient video saliency prediction by knowledge distillation

Video saliency prediction has recently attracted attention of the research community, as it is an upstream task for several practical applications. However, current solutions are particularly computationally demanding, especially due to the wide usage of spatio-temporal 3D convolutions. We observe that, while different model architectures achieve similar performance on benchmarks, visual variations between predicted saliency maps are still significant. Inspired by this intuition, we propose a lightweight model that employs multiple simple heterogeneous decoders and adopts several practical approaches to improve accuracy while keeping computational costs low, such as hierarchical multi-map knowledge distillation, multi-output saliency prediction, unlabelled auxiliary datasets and channel reduction with teacher assistant supervision. These approaches enhance significantly the efficiency of the model, while achieving saliency prediction accuracy on par or better than state-of-the-art methods on large scale video saliency dataset like DFH1K, UCF-Sports and Hollywood2 benchmarks.

Kevin Höfle
BASLER AG

Pro and Cons of using AI-Black Box Applications: Collecting experience on a urine sediment analysis project

Keras, Pytorch, Coffee and co are well known frameworks for deep learning applications. However, recently a new category came up: GUI applications for training and deploying neural networks. Covering up the code that is needed for training and deploying deep learning algorithms in a black box. With the promise of an easier introduction into Machine Learning and a higher abstraction of commonly used functionalities, this approach looks tempting. This was put to the test in a urine sediment analysis, where a localization and classification was done, using eIQ Portal and an NXP i.MX 8m PLUS EVK.

Dr. Thomas Bocklitz
Leibniz-IPHT department "Photonic data science", Leibniz Institute of Photonic Technology, Member of Leibniz Health Technologies, Member of the Leibniz Centre for Photonics in Infection Research (LPI), Albert-Einstein-Straße 9, 07745 Jena, GermanyIPHT Jena

Machine learning techniques for photonic imaging techniques

Photonic data can be used to characterize the biochemical composition of samples and often in a non-destructive and label-free manner. To utilize these label-free measurements for applications like diagnostics or analytics, machine learning based modeling is utilized to translate photonic data into higher-level information and knowledge.

In this contribution machine learning based modeling of photonic in two application scenarios will be presented. In the first scenario image data consisting of coherent anti-Stokes Raman spectroscopy (CARS), two-photon-excited fluorescence (TPEF) and second harmonic generation (SHG) will be translated into diagnostic information. This includes the prediction of tissue types [1] or disease types [2]. In a second application scenarios, we show the translation of these nonlinear multi-contrast images into a different image domain, like the histopathological staining domain [3]. Finally, the advantages and disadvantages of the use of machine learning methods for both tasks will be discussed.

Sylvia Schmitt
Leica Camera AG

Challenges when deploying a ML Research results to Production for Embedded Devices

Embedded devices have lower computational power and several other limitations that make the use of machine/deep learning models on these devices challenging. Some of these challenges will be highlighted in this talk and why it is important to consider them during model development phase, focusing on the use for embedded devices and what is different compared to ML/DL development in research.

Computational Imaging 2023:
Expert Forum with International Specialists in Wetzlar

10. & 11. May, 2023

Biographies

Ivo Ihrke

is a professor of Computational Sensing at University of Siegen, Germany. Prior to joining Siegen, he was a staff scientist at the Carl Zeiss research department, which he joined on-leave from Inria Bordeaux Sud-Ouest, where he was a permanent researcher. At Inria he lead the research project "Generalized Image Acquisition and Analysis" which was supported by an Emmy-Noether fellowship of the German Research Foundation (DFG). Prior to that he was heading a research group within the Cluster of Excellence "Multimodal Computing and Interaction" at Saarland University. He was an Associate Senior Researcher at the MPI Informatik, simultaneously associated with the Max-Planck Center for Visual Computing and Communications, a collaboration with Stanford University. Before joining Saarland University he was a postdoctoral research fellow at the University of British Columbia, Vancouver, Canada, supported by the Alexander von Humboldt-Foundation. He received a MS degree in Scientific Computing from the Royal Institute of Technology (KTH), Stockholm, Sweden and a PhD (summa cum laude) in Computer Science from Saarland University.

He is interested in all aspects of Computational Imaging, including theory, mathematical modeling, algorithm design and their efficient implementation, as well as hardware concepts and their experimental realization and characterization. He performed pioneering studies in 3D BOS and 3D flow velocimetry. He introduced a novel light field imaging objective lens and contributed to light field theory development. He is a co-founder of K|Lens GmbH, a company marketing the light field objective lens.

Mark Benyamin

Mark Benyamin graduated with a Master of Engineering degree in Media Technology at RheinMain University of Applied Sciences in 2021. He is currently working as a research assistant at RheinMain University in two research projects dealing with AI-based HDR image reconstruction in the area of film and broadcast as well as smart mobility applications. In the future, he aims to pursue a PHD in the field of SDR image reconstruction and enhancement using Deep Learning.

Pascal Kutschbach

Pascal Kutschbach graduated with a Master of Engineering degree in Media Technology at RheinMain University of Applied Sciences in 2021. He is currently working as a research assistant at RheinMain University in a research project dealing with AI-based HDR colorspace expansion in the area of film, broadcast and cloud applications. In the future, he aims to pursue a PHD in the field of colorspace transformation methods using Deep Learning.